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1922/23

The Bulletin of the University of Minnesota

*Announcement of
Courses in Plant Science Available in
the Several Schools and Colleges
1922-1923*



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1922							1923													
JULY							JANUARY							JULY						
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31	30	31

UNIVERSITY CALENDAR

1922-23

1922

September	16	Saturday	Payment of fees closes, except for new students
September	19-26		Examinations for removal of conditions and entrance examinations Physical examinations for all new students
September	19-23		Registration period, colleges of Science, Literature, and the Arts, and Agriculture, Forestry, and Home Economics
September	25-26		Registration days for all colleges not indicated above
September	26	Tuesday	Payment of fees for new students closes
September	27	Wednesday	Fall quarter begins, 8:30* a.m.
October	14	Saturday	Class Scrap Day; classes dismissed the third and fourth hours
October	26	Thursday	Senate meeting, 4:30 p.m.
November	4	Saturday	Home Coming Day; classes dismissed the third and fourth hours
November	7	Tuesday	General Election Day; a holiday
November	11	Saturday	Armistice Day; a holiday
November	30	Thursday	Thanksgiving Day; a holiday
December	14	Thursday	Senate meeting, 4:30 p.m.
December	20	Wednesday	Fall quarter ends, Christmas vacation begins, 5:20 p.m.

1923

January	4	Thursday	Christmas vacation ends, winter quarter begins, 8:30* a.m.
February	12	Monday	Lincoln's Birthday; a holiday
February	15	Thursday	Senate meeting, 4:30 p.m.
February	22	Thursday	Washington's Birthday; a holiday
March	23	Friday	Winter quarter ends, spring vacation begins, 5:20 p.m.
April	4	Wednesday	Spring vacation ends, spring quarter begins, 8:30* a.m.

Information in regard to dates of registration, etc., can be obtained from bulletin of general information.

* First hour classes begin at 8:15 at University Farm.

May	17	Thursday	Senate meeting, 4:30 p.m.
May	30	Wednesday	Memorial Day; a holiday
June	17	Sunday	Baccalaureate service
June	20	Wednesday	Fifty-first annual commencement
June	20	Wednesday	Spring quarter closes, 5:20 p.m.
June	23-25		Registration days for Summer Session
June	26	Tuesday	Summer Session and summer quarter begin
July	4	Wednesday	Independence Day; a holiday
August	3	Friday	Summer Session closes
September	7	Friday	Summer quarter closes

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ROBERT G. GREEN, M.A., Instructor in Bacteriology
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MADELEINE GUILLEMIN, B.A., Teaching Fellow in Bacteriology and Botany

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LEE I. KNIGHT, Ph.D., Professor of Botany
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HARRY H. KNIGHT, Ph.D., Assistant Professor of Entomology
OSCAR W. OESTLUND, Ph.D., Assistant Professor of Animal Biology
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ECONOMICS

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JOHN W. BUSHNELL, M.S., Instructor in Horticulture
FRED A. KRANTZ, M.S., Instructor in Horticulture

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CHARLES E. SMYTHE, Assistant in Pharmacognosy

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FORESTRY, AND HOME ECONOMICS

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ALVIN H. LARSON, B.S. in Agr., Assistant Professor of Agricultural Botany
JULIAN G. LEACH, M.S., Assistant Professor in Plant Pathology
HENRY D. BARKER, M.S., Instructor in Plant Pathology
LOUISE DOSDALL, M.A., Instructor in Plant Pathology
JAMES L. SEAL, M.S., Instructor in Plant Pathology

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FREDERICK J. ALWAY, Ph.D., Professor of Soil Chemistry

CLAYTON O. ROST, Ph.D., Assistant Professor of Soils

PAUL R. McMILLER, M.S., Instructor in Soils

Information concerning the plant science courses may be obtained from members of the

COMMITTEE ON BULLETIN

Dean Edward M. Freeman, University Farm, St. Paul, Minnesota

Professor C. Otto Rosendahl, University of Minnesota, Minneapolis,
Minnesota

Professor Ross A. Gortner, University Farm, St. Paul, Minnesota

PLANT SCIENCE COURSES AT THE UNIVERSITY OF MINNESOTA

FUNDAMENTAL AIMS

Modern study and research in plant science can be pursued to best advantage only under healthy conditions of coöperation, a coöperation amongst equals in an intellectual and scientific democracy. It is the aim at the University of Minnesota to promote this coöperation in every profitable phase. This bulletin is the result of the combined efforts of plant scientists from several widely separated colleges and departments of the University. The best results can be obtained only by the elimination of college, departmental, and other administrative lines, and the concentration of kindred interests upon the problems of research and of the training of investigators. Many investigators and teachers in all phases of the sciences which contribute to the general field of plant science—biochemists, bacteriologists, botanists, mycologists, geneticists, horticulturists, and many others have been joining together in the solution of specific research problems. They are desirous of carrying this coöperation into the field of training students and investigators so that such students and investigators shall have broad foundations and at the same time the intense special training which is essential to their future success. In the increasing complexities of modern science such success can be obtained only by thoro preparation in carefully selected branches of the general field. It is hoped that this bulletin will make clear to the student the possibilities of such training at Minnesota.

The possibilities in research at Minnesota are further broadened by numerous opportunities of contact with organizations outside of the University. A number of departments maintain extensive coöperation with various offices of the United States Department of Agriculture, especially in cereal breeding and cereal disease work. Joint projects are maintained with the various divisions of the State Department of Agriculture in the seed laboratory, potato seed certification, cereal chemistry and the state experimental flour mill, state nursery inspection, and other branches. One of the most interesting and gratifying types of coöperation has been begun with excellent prospects of results with the Canadian educational and research institutions of the northwest in the solution of plant science problems common to the two countries.

It is the ambition of the plant science group of the University of Minnesota—an informal group which is bound together not by administrative ties, but by common purpose bonds—to exalt the research problem and the training of the investigator and to minimize the emphasis on the administrative organization of departments and colleges.

GENERAL INFORMATION

This bulletin presents to resident and prospective students of the University a list of the courses offered in the various colleges and schools which have to do directly and indirectly with the study of plants.

To undergraduates it is intended to show the diversity of plant interests, some of the possibilities of a knowledge of plant science, the various courses offered to one preparing for a profession in this special field, and the correlation of the various plant science courses in the many different phases of this particular branch of science. A study of these correlated courses should enable the student early in his career to realize that if he is to make the greatest success in the study of plants the foundations of knowledge should be broadly laid.

To graduate students the list shows concisely yet fully the range of possibility of election of courses in plant science. This applies not only to the major field, but also to the minor and supporting fields of graduate study. The more definite the object of the graduate student in selecting his courses the easier becomes such selection. It is hoped that this list will show the wide range of possibilities and make selection easier and most profitable. The regulations of the Graduate School should be kept closely in mind as should also the prerequisites of the various courses.

Supporting subjects.—The attention of the student is also especially called to the fact that frequently subjects and courses not listed here and not primarily plant science courses may be of paramount importance in a given line of study. A few of them are here enumerated more as illustrations than as an attempt to furnish a complete list: animal biology (College of Science, Literature, and the Arts), economic entomology and zoology (College of Agriculture, Forestry, and Home Economics), chemistry (School of Chemistry, especially the divisions of Organic Chemistry and Physical Chemistry), pharmacology (Medicine), physics (Science, Literature, and the Arts), geology (Science, Literature, and the Arts).

Foreign languages.—Any student who contemplates continuing plant science as a special line of study is strongly advised to obtain at as early a date as possible, proficiency in one or both of the modern languages of German and French. A knowledge of Latin, Italian, and the Scandinavian languages is also very useful.

Seminars, special lectures, etc.—The usual departmental seminars are listed under the subject-matter statements. In addition, there is a Special Plant Science Seminar which meets once a month during the academic year. Topics of general interest to the entire plant science group are discussed. The Program Committee of the Plant Science Seminar is often able to secure speakers of national reputation in the plant science field. This seminar carries no college credit; registration for the seminar is not required, but graduate students are urged to attend. Topics presented at this seminar, together with the ensuing discussions, will assist materially in securing a view of the entire field of plant science.

The Biological Club meets once in two weeks, alternating with the Plant Science Seminar. Topics of general biological interest are discussed. Most of the scientific meetings are open to those interested in the broad field of biology, and graduate students are especially invited to be present.

Scientific societies.—There are a number of scientific societies which hold regularly scheduled meetings at the University or in the adjacent Twin Cities. Among these are the Minnesota Section of the American Chemical Society, the Minnesota Section of the Society for Experimental Biology and Medicine, the Minnesota Section of the Society of Milling and Baking Technology, the Minnesota Mycological Society, the Minnesota Horticultural Society, and the Society of the Sigma Xi. The honorary chemical society, Phi Lambda Upsilon, and the honorary agricultural society, Gamma Sigma Delta, present from time to time scientific lectures by men of prominence. The scientific programs of these societies are open to all who may be interested.

Fellowships, scholarships, and assistantships.—There are a number of fellowships and scholarships open to *graduate* students. In addition there are a large number of assistantships open in the various divisions or departments. Such assistantships require that a certain amount of service should be rendered, either in the classroom or in the Agricultural Experiment Station. The Department of Agriculture has prepared a circular describing in detail the fellowships, scholarships, and assistantships available in that department. This may be secured by addressing the dean of the College of Agriculture. Similar information regarding other colleges may be secured by addressing the dean of the particular school or college concerned or communicating with the head of the department in which major work will be presented. Holders of graduate fellowships, scholarships, or assistantships are exempt from the payment of tuition.

There are likewise a number of *undergraduate* scholarships and assistantships. Information regarding these may be obtained through the registrar or the dean of the college in which the student is registered.

Graduate work in the summer quarter.—Work of graduate character done in the Summer Session of the University of Minnesota under a member of the graduate faculty may be counted for residence credit for advanced degrees. The course work for the Master's degree may be completed in four summer sessions of six weeks each. Students working for the Master's degree in summer sessions must file the subjects of their theses before the completion of the first half of the required work.

An increasing amount of graduate work in fields of plant science is being offered during the summer. Several departments are offering lecture and laboratory courses extending through an entire summer quarter. Three such summer quarters may complete the requirements including the preparation of a satisfactory thesis for a Master's degree. Advanced students who are prepared to undertake thesis work may register for a full summer quarter's work in many of the departments whose announcement appears in this bulletin. Students contemplating such registration should communicate with the head of the department in which they expect to major in order to ascertain whether or not a full quarter's work is available.

A number of undergraduate courses are offered in the six weeks' Summer Session. The courses may be found in the bulletin of the Summer Session.

Students who desire graduate credit for work in the summer must register with the dean of the Graduate School.

Undergraduate student regulations.—Rules governing undergraduate work differ in the various colleges within the University. The undergraduate student must of necessity consult the bulletin of the college in which he is or intends to be registered. He should particularly consider carefully (a) the regulations of the college in which he is registered in regard to the possibility of taking work in other colleges and (b) the prerequisites of the desired courses.

Graduate student regulations.—Graduate work in the University of Minnesota is not controlled by the individual colleges but is under the direction of the faculty of the Graduate School. An extended statement of the rules governing graduate study and the requirements which must be met before advanced degrees can be conferred will be found in the bulletin of the Graduate School which may be obtained upon application to the dean of the Graduate School.

The following is an abbreviated statement of the essential requirements for advanced degrees; for further details consult the bulletin of the Graduate School.

REQUIREMENTS FOR THE MASTER'S DEGREE

The degree of master of arts is, in general, conferred for advanced non-technical study; the degree of master of science for advanced technical study, such as agriculture, industrial chemistry, engineering, etc.

The requirements for the degrees of master of arts or master of science are covered in general by the statement that these degrees may be earned by properly qualified students only by at least one full academic year's work in residence at this University (three quarters). Students who have not adequate preparation in the specific chosen field of work, or who are doing outside work in excess of ten hours a week, will require more than one year to attain the Master's degree.

TABULAR SUMMARY OF REQUIREMENTS FOR THE MASTER'S DEGREE

WORK	UNDER THE DIRECTION OF	DATE
Program, major and minor	Adviser and dean of the Graduate School.....	On entrance.
Approval of thesis subject	Adviser and group committee	Middle of first quarter in residence.
Language requirement.....	Adviser and language department	Before close of second quarter.
Approval of candidacy....	Executive committee....	Beginning of third quarter.
Filing thesis.....	Dean of the Graduate School	At least six weeks before graduation.
Examination of thesis....	Thesis committee.....	Before admission to final oral examination.
Final written examination in major	Major department members of the graduate faculty	Not later than four weeks before commencement and before final oral.
Final oral examination on all work	Thesis committee; all candidate's instructors; head of major department....	Not later than two weeks before commencement.
(Course examinations as required at the usual time.)		
Fee for binding thesis....	Registrar	One week before commencement.

DOCTOR'S DEGREE

In the Graduate School, one Doctor's degree, doctor of philosophy (Ph.D.) is conferred by the University of Minnesota. This degree is granted, not on the basis of successful completion of a definite amount of prescribed work but solely in recognition of the candidate's high attainments and ability in this special field, to be shown, first, by the preparation of a thesis, and, second, by successfully passing the required examinations covering both the general and the special fields of the candidate's subjects as detailed later.

Candidates for the Doctor's degree must devote at least three years* of graduate study to approved subjects. The first two years or the last year must be spent in residence at the University of Minnesota.

TABULAR SUMMARY OF REQUIREMENTS FOR
THE DOCTOR'S DEGREE

WORK	UNDER DIRECTION OF	DATE
FIRST YEAR		On registration
Major	Adviser and dean of Graduate School.	
Minor		
SECOND YEAR		
Tentative program of entire second and third year's work.	Adviser, group committee, and dean of Graduate School.	Before beginning work of second year.
Major, including thesis...	As for tentative program	Before admission to preliminary examination
Minor	Adviser and minor department.	
Language	Adviser and language department.	
Recommendation	By major department.....	
Preliminary examination...	Special committee	One calendar year before degree is to be conferred.
THIRD YEAR		
Major, including thesis...	Adviser, group committee, and dean of Graduate School.	
Filing of thesis.....	Dean	Six weeks before taking the degree.
Examination of thesis....	Thesis committee	Before admission to final oral examination.
Final written examination	Major department members of the graduate faculty.	Four weeks before taking degree and before final oral examination.
Final oral examination....	Adviser, majority of members of major department, and other members appointed by dean of the graduate faculty.	Not later than two weeks before taking the degree.
Bond for publication of thesis	Registrar	Not later than one week before taking the degree.

* This time requirement will be met in three years only by those students who devote all their time to graduate study. Students who merely devote the intervals of professional or other regular employment to graduate study will need to extend their total period of work over a longer period of time. Credit for such work will be given in proportion to the amount of time actually spent in the pursuit of graduate work.

PROFESSIONAL OPPORTUNITIES OPEN TO STUDENTS
OF PLANT SCIENCE

Students specializing in any of the fields of work in plant science are strongly advised to continue the course leading to the higher degrees.

The United States Department of Agriculture and the various state agricultural colleges and experiment stations offer many opportunities for research or teaching positions. *In addition to Federal or state work* the following list enumerates some of the positions open to students specializing in the various fields.

Bacteriology.—Teaching positions in colleges or medical schools, hospital and clinical laboratories, public health laboratories, etc.

Botany.—In addition to positions in teaching in high schools, normal schools, colleges, universities, and experimental work, opportunities are offered in research institutes, in museums, and in various commercial lines. A thoro training in botany is fundamental to all the other lines of plant science.

Farm crops.—County agricultural agents, agricultural extension work, and the various phases of business which need special agricultural training.

Forestry.—Teaching positions in colleges of forestry; positions with corporations dealing in lumber or with private firms having large timber holdings; paper mills, research or control laboratories, etc.

Genetics and plant-breeding.—Specialists with seed firms, nurseries, or the privately endowed research institutions.

Horticulture.—Teaching and research positions in colleges and experiment stations. In many sections of the country county agricultural agents, with special horticultural training, are being appointed. Agricultural high schools are seeking men with horticultural training because of the facility with which horticultural subjects can be handled in high schools. Nurserymen, seedsmen, and plant growers are more and more utilizing the services of trained horticulturists and more than ever are trained horticulturists in demand as managers and superintendents of fruit farms and estates.

Plant chemistry.—Chemists in the laboratories of the flour mills or the grain trade; chemists or assistants in hospital laboratories; chemical positions with industrial corporations, especially those dealing with biological or agricultural products or using such products in their manufacturing processes; private commercial laboratories for analytical work or research, etc.

Plant pathology.—State departments of agriculture; some positions as county or local advisers for crop producers' associations; positions with fruit companies and large commercial organizations; a few with railroads as experts in transportation diseases; a constantly widening field in tree surgery.

Plant physiology.—In addition to many teaching positions there is a growing demand for plant physiologists in (a) various research institutes and (b) with commercial organizations such as fertilizer corporations, sugar corporations, rubber companies, fruit growers' associations, and others.

Pharmacognosy.—Positions in colleges of pharmacy; in commercial laboratories or with corporations dealing in drugs.

Seed-testing.—State departments of agriculture, seed firms, etc.

FACILITIES OFFERED AT THE UNIVERSITY OF MINNESOTA FOR WORK IN PLANT SCIENCE

In order that prospective students may understand more clearly what the University and State of Minnesota have to offer, a brief account of the opportunities and advantages for the study of plant sciences is presented. The special advantages for the work in individual departments is also given below.

NATURAL ADVANTAGES

The topography, geology, climatology, floras, and other natural features of the state offer certain peculiarities of interest to the student or investigator. In the great variety of conditions prevailing, students may find these of particular value and of special advantage in working out problems in which they are primarily interested.

Geologically Minnesota presents some of the oldest rock formations on the American continent. It also contains areas representing all important glaciations as well as two northern extensions of the great loess area, one of which was naturally forested and the other prairie. There are large areas of glacial and lacustrine and stream-formed deposits, and loess and other wind-formed soil areas upon which have been developed prairie and forest vegetation. In peat lands Minnesota leads all the other states of the Union, both in the total acreage and the proportion of the surface occupied, with approximately 7,000,000 acres or one eighth of the area of the state. The ten thousand lakes varying in size from small ponds to the great Lake Superior offer almost every conceivable variation in the ecology of fresh water aquatic flora. The extensive publications of the Geological and Natural History Survey of Minnesota constitute an excellent basis for the study of Minnesota plant life. A reconnaissance soil survey of the northern part of the state has been started and detailed surveys of representative areas are already available.

The climatology of the state also offers desirable features. The annual rainfall, varying from twenty inches in the northwest to thirty-two inches in the southeast, offers opportunities for study and experimentation. Temperature variations are also large and furnish especially good opportunities for study and research in the temperature relations of crop and plant distribution. Restricted areas of peat are liable to frequent summer frost. The range of ecological factors from open prairies of the west to the cold and moist peat bog of the northeast presents innumerable possibilities for field study. The soils of Minnesota range from black calcareous prairie soils to the gray to whitish soils of the coniferous forests which are closely related to the podzols of northern Russia.

The state is liberally supporting soil experimentation and the opportunities for study and investigation in connection with these activities are quite exceptional.

Botanically the state furnishes exceptional advantages in the variety of floras and in the great range of ecological environment. They include the vast coniferous forests of the north, the prairies of the south and west, and between these the hardwood areas. These possibilities are further discussed under Botany.

OPPORTUNITIES FOR FIELD WORK

The University of Minnesota maintains a large number of experiment stations so distributed over the state that the important agricultural areas are well represented.

The central and main station of 422 acres is on the University Farm campus which is connected with the main University campus, three miles distant, by a special trolley line. The Crookston Station (476 acres) is located in the northwestern part of the state on the heavy black lacustrine soils of the old Lake Agassiz basin. The Morris Station (292 acres) is in the west central part of the state on black silt loam soil representative of that region. The Waseca Station (246 acres) is in the south central part in the corn belt and in the border belt of winter and spring wheat areas. The Grand Rapids Station (454 acres) in the north central part of the state is typical of great coniferous areas and together with the Duluth Station (252 acres) furnishes opportunities for a study of many of the problems in this region.

A special fruit-breeding farm of 109 acres is maintained at Zumbra Heights, in the heart of the Lake Minnetonka fruit region, with excellent greenhouse, laboratory, and field equipment. It is twenty-five miles from Minneapolis and easily accessible by train and trolley.

In connection with the state work on soils, in addition to the regular stations, eleven special field stations are available on high-lime peats, light sands and low-lime soils of southeastern Minnesota, representative of extensive soil areas.

The forestry interests of the state are also represented by several stations and by state and Federal forest reserves. The Cloquet Forest Experiment Station is located in the northeast section of the state. It consists of 2,662 acres with excellent stands of virgin timber, is well equipped with building and field experiment facilities, is close to the town of Cloquet where large lumber mills and pulp mills are located. The Lake Itasca Forest Station is also well equipped with buildings and is located at the head waters of the Mississippi River in a large state park and forest reserve of about 50 square miles with a variety of stands of virgin timber and unexcelled opportunities for field studies in forestry and general biological fields.

Within the state are also the Cass Lake National Forest near the head waters of the Mississippi and the Superior National Forest in the low

mountainous region of the extreme north and northeast. State forest reserves are also maintained at Burntside Lake, at Carlton, and at other points, making a total of 373,000 acres in the state.

LIBRARIES

The library facilities in plant science at the University of Minnesota are adequate for the student and investigator of almost every branch of plant science. The general University library is soon to be housed in a large and suitable modern building. The general library of the College of Agriculture is located at the University Farm and is fairly complete. The various college and department libraries are also available. Outside of the University there are accessible in the Twin Cities the J. J. Hill Reference Library and the State Historical Library, both of which are located in St. Paul, and the city libraries of both St. Paul and Minneapolis.

DEPARTMENTAL STATEMENTS

BOTANY

LIBRARY

The library consists of an exceptionally fine collection of about 8,000 bound volumes and several thousand cataloged pamphlets. The collection of bound volumes includes complete sets of all the principal botanical periodicals of the world together with the principal series of monographs on systematic botany. An important feature of the library is the large collection of herbals which embraces such treasures as the originals of Brunfels, Fuchs, Dodaens De Lobel, and many others. Another noteworthy collection is the Holway Library which is unquestionably the richest in the middle west on fungi and on the rusts in particular.

HERBARIUM

The herbarium of the University of Minnesota is the fifth largest in North America, being exceeded only by the collections at Harvard, New York Botanical Garden, The National Herbarium, and possibly the Herbarium of the Missouri Botanical Garden. It embraces the splendid collection of rusts of Mr. Holway, which is particularly rich in types and rare exchanges. The algological collection is one of the best in North America; all but the latest collections are accessioned and the herbarium is arranged on an easily workable basis. In the building up of the herbarium special emphasis has been placed on the acquisition of North American and European plants.

FIELD WORK

The University of Minnesota is favorably located for field work in taxonomy, ecology, and forestry. Three distinct floras meet and mingle in the immediate environs of the Twin Cities and they are all easily accessible for work. A typical undisturbed prairie flora is found on the Fort Snelling Military Reservation adjoining Minneapolis on the south. This area is over 1,000 acres in extent and practically the entire tract has never been disturbed. The mixed hardwood deciduous forest, locally known as the "Big Woods," lies immediately to the west of Minneapolis, with scattered areas of the same formation both to the east and south. The northeast coniferous forest reaches its southern continuous limit within twenty miles of the University with numerous outposts much nearer. Tamarack swamps are numerous and contain many elements of the northern forest. River gorges and flood plains together with innumerable streams, lakes, swamps, and marshes offer an exceptionally wide variety of conditions for the development of different types of vegetation. These conditions are further enhanced by the fact that terminal moraines of the different ice sheets swing in great circles around the Twin Cities and till and outwash plains of varied chemical nature as well as characteristic sand dunes abound.

The University greenhouses altho not very extensive are well stocked with native and exotic plants and the aim has been to utilize the space available in providing ample supplies of fresh material for class use along the various lines of work.

PRESERVED MATERIAL AND MUSEUM SPECIMENS

Large stocks of preserved material of plants which can not be grown locally or at the time when needed are kept on hand. This reserve consists of thousands of jars representing all the large groups of plants and among these the algological collection is particularly noteworthy since it is the largest one of Pacific algae in the country.

BACTERIOLOGY AND IMMUNOLOGY

The Department of Bacteriology and Immunology offers opportunities for technical and theoretical training in the variety of branches as well as in bacteriology as a pure science. For those interested in medicine or in medical laboratory work there is the special course in bacteriology for medical students dealing with the more important pathogens and theoretical consideration as to the nature and progress of infection and immunity. This course may well be followed by the courses in immunity, higher bacteria, pathogenic Protozoa, etc., and by special research problems for qualified students. In addition to the departmental museum, the University Hospital and the dispensary are a continuous source of material. The proximity and coöperation of the State Board of Health and the departments teaching the other fundamental medical sciences, facilitate the arrangement of a varied and thoro course for those interested in this field.

The advanced course in household bacteriology which may be followed by any amount of supervised work on special problems can well be correlated with work in the Department of Home Economics, the amount and scope of the work being limited only by the maturity and interest of the student.

The same is true of work in agricultural bacteriology. Unlimited material can be obtained from the University Farm campus. The course covers soil and dairy bacteriology and work on animal and plant pathogens. Problems in soil and water bacteriology have been undertaken by students and various similar pieces of individual work are available. The approach to work in industrial bacteriology is principally through training in household or agricultural bacteriology.

An exceptional feature of study at Minnesota is the opportunity afforded for work in bacteriology as a pure science. The department has an unusual equipment of electrical and other devices for physical and chemical tests and measurements and the student desirous of a thoro knowledge of the bacterial cell as such will be well grounded in the courses in morphology and taxonomy and in bacteriological chemistry. Advanced students of botany or plant physiology, especially those interested in the fungi or algae, will find these courses of especial benefit. Research on such problems is constantly under way.

Reports on the progress of investigations by members of the department, fellows, and students, and reviews and discussions of the latest publications from other institutions take place at the departmental seminars.

FORESTRY

The Department of Forestry offers advanced work in the fields of silviculture, forest products, forest management, and lumber economics.

In the wood laboratories intensive work may be carried on in studies of physical and mechanical properties of American and foreign woods, in wood structure and identification, in wood uses and substitutes, in plywoods, in by-products, and in wood preservatives. The varied wood-using industries of the Twin Cities are always open to students interested in wood.

A good collection of American and foreign wood specimens is available.

The Forest Experiment Station at Cloquet affords unequalled facilities for advanced study and research in silvics, in natural and artificial reproduction methods, in nursery practice, and in forest management problems.

The training station at Itasca offers facilities for field studies in silviculture and nursery practice during the summer months.

Records of intensive silvical research covering a period of ten years are available.

The library contains copies of the most important works in forestry and pertaining to forestry, in the English language as well as all the standard works in foreign languages. Complete files of all publications of the states, of the Federal government, of foreign countries, and all technical forestry journals are available, as well as most of the lumber and wood-using journals published in this country.

Coöperative facilities at University Farm and at the stations at Itasca and Cloquet are extended to specialists in forest entomology, forest pathology, and forest zoology.

Altho Minnesota does not contain the large stands of timber which it formerly possessed there are still large holdings and extensive cuttings. Numerous opportunities still exist for study of forest management, lumbering, and marketing problems in the great forest areas of the state. Large areas for reforestation are available. Large pulp and paper mills, lumber mills, the National Forest, and the state forests, the activities of the United States Forest Service and the Minnesota State Forestry Service offer numerous opportunities for study in almost all fields of forestry.

HORTICULTURE

FRUIT-BREEDING FARM

A one hundred nine acre farm entirely devoted to the breeding of fruits is operated under the direction of the Division of Horticulture. This furnishes an unusual opportunity for students who are interested in questions of genetics and fruit-breeding to study a wide range of breeding

material and of seedlings. A good collection of hardy species is maintained for breeding purposes and seedlings running into the tens of thousands are available for studies in character inheritance, hardiness, sterility, etc. Numerous problems connected with the breeding of fruits involve the fields of cytology, microchemistry, biochemistry, and plant physiology. Those who are also interested in some of these phases of science can find a ready opportunity to select research problems that can be completed in a comparatively short time.

GREENHOUSE FACILITIES

Both at the Fruit-Breeding Farm and at the University Farm the Horticultural Division is equipped with greenhouses in which graduate students may have suitable space for growing material during the winter in connection with thesis projects.

VEGETABLE PRODUCTION

From ten to fifteen acres of land at the University Farm are utilized for the production of vegetables. Comprehensive strain and variety tests are conducted in addition to cultural studies. There is ample opportunity for the development of research problems in this field. Work in vegetable-breeding and selection has been in progress for a number of years and a considerable amount of interesting material is on hand.

FRUIT PRODUCTION

On University Farm some fruit culture experiments are in operation as well as fruit variety studies. On nearby places under coöperative arrangements with private growers a considerable amount of orchard material is available for investigational use.

ORNAMENTAL HORTICULTURE

The University Farm campus is under the supervision of a member of the Horticultural Division and contains a good collection of hardy species of plants, shrubs, and trees. This, together with the annual and perennial garden, furnishes a wealth of material to the student interested in the study of hardy ornamentals.

PHARMACOGNOSY AND PHARMACEUTICAL BOTANY

MEDICINAL PLANTS GARDEN

The garden comprises about two acres devoted to the culture of medicinal plants for educational purposes. Several hundred species of the more important annual, biennial, and perennial medicinal plants are under cultivation and available for study. A slat house provides facilities for growing shade-loving plants. The collection includes many plants native to foreign countries only. Opportunities for studying the effects of variation in factors influencing plant growth especially upon constituents are afforded.

MEDICINAL PLANT CONSERVATORY

The pharmacy greenhouse laboratory contains a collection of the more important medicinal plants of the tropics. Some of these are grown in sufficient quantity to afford ample material for work along morphological, phytochemical, and other allied lines. Facilities are also available for studying the problems concerned with the propagation and cultivation of medicinal plants.

DRUG-DRYING AND MILLING

The equipment is especially designed for carrying out the processes of dehydration and comminution required for practical routine work and research on medicinal and other economic plants. It includes a battery of drying ovens having a capacity of approximately five hundred pounds of fresh plant material; steel storage carriage bins; a high speed disintegrator mill; a Schutz-O'Neill high speed limited pulverizer; a Hance horizontal cone plate mill; numerous small vertical cone plate mills; a gyrator sifter; a fanning mill; a thresher; standard testing sieves; etc. The machinery is all motor driven and sufficiently varied in character to permit of the production of almost any quantity or character of product desired.

VEGETABLE DRUG COLLECTIONS

Over three thousand specimens of powdered vegetable drugs and spices and nearly as many unpowdered specimens are cataloged and indexed in the collections of the Department of Pharmacognosy. In addition a representative collection of fresh preserved material is available. The specimens are all arranged for immediate access and study. In the development of the collections, special attention has been given to the authenticity and purity of the powdered products. A large number of the powdered drugs have been produced from hand brushed specimens and many from drugs produced from the plants grown in the medicinal plant garden. The value of these collections is greatly increased by reason of their use as the bases for establishing Federal and state standards for drugs and spices under the Food and Drug Act. Upwards of ten thousand permanent microscopic mounts are available for instructional and comparative studies. An excellent collection of photographic negatives and photographic prints of medicinal plants is maintained.

Microscopes, microscopical accessories, charts, models, physiological, chemical, and photographic apparatus and the usual facilities and equipment required for carrying on the various lines of pharmacognostical work are provided.

PLANT-BREEDING AND FARM CROPS

The field plots which are used by the Division of Agronomy and Farm Management for farm crops and plant-breeding experiments are located at University Farm and are available for those students who desire to specialize in these lines. In many cases some phase of a station project may be handled by the graduate student. Studies of this nature must be continued during the summer.

Coöperative studies in the genetics of disease resistance are being carried on by the divisions of Plant Breeding and Plant Pathology. For the student who wishes to undertake this line of work, the opportunities at Minnesota are exceptionally good. Adequate material for the study of the taxonomy of crop plants is available for the student who wishes to specialize in this field. Material and equipment are also available for statistical studies. Fair equipment for cytological and histological studies is available.

The library of the Department of Agriculture contains most of the important journals which are of use to the student of crops or of plant-breeding.

Summaries of earlier farm crop and plant-breeding studies together with an index file of recent crop production and crop genetic literature are a part of the equipment.

PLANT CHEMISTRY

The Division of Agricultural Biochemistry emphasizes those phases of chemistry which are concerned with living processes. A considerable part of the work is designed in particular for students of plant science. The laboratory equipment and apparatus are representative of the more modern demands in this field. Complete apparatus for the determination of hydrogen ion concentration by either the potentiometric method or colorimetric method is available. The research laboratory is equipped with a constant speed high frequency A. C. generator and other apparatus for the determination of electrical conductivity. Electric vacuum ovens, electric drying ovens, constant temperature thermostats and incubators, refractometers, colorimeters, nephelometers, polariscope, centrifuges, including a supercentrifuge capable of exerting a pressure of 40,000 times gravity, several complete sets of Van Slyke's amino nitrogen apparatus, ultra microscope, MacMichael viscosimeter, autoclaves, hydraulic press, and mills of various kinds represent some of the more special apparatus.

Library facilities include not only the departmental library but the large libraries of the School of Chemistry and the School of Medicine on the Minneapolis campus. The personal libraries of the various staff members are made available to advanced students.

Particular attention is devoted to instruction and research in the fields of colloids, proteins, carbohydrates, enzymes, and vitamins, and their rôles in living processes.

A well-equipped experimental outfit for making syrups is available, and is used for studying methods and processes in the utilization of syrup-producing plants. There is also available near the Twin Cities a large modern sorghum syrup factory, equipped with filter presses, vacuum pans, and many unique pieces of machinery, with which the division has a co-operative arrangement for large scale studies of sugar problems.

Facilities are available for obtaining unlimited quantities of yeast for biochemical or physiological studies.

One of the major projects of the division is the biochemistry of plant diseases, and the divisions of Plant Pathology and Agronomy are actively coöperating on this problem.

The vitamine laboratory has cage space for about 500 small animals. In addition, coöperation with the Dairy Division provides for large animal studies. Emphasis in vitamine work is largely placed on the plant as the original source of these essential substances.

Facilities for advanced study and research in the field of cereal technology include laboratories provided with not only the conventional equipment, but an experimental flour mill, dough mixers, fermentation cabinets, bake ovens, and other devices for conducting small scale milling and baking experiments. Several private libraries of books, journals, and collections of reprints, along this and related lines, are available to advanced students. In addition, through the coöperation of the state experimental flour mill (150 barrels daily capacity), the baking department of Dunwoody Industrial Institute, and of several large commercial bake shops of the Twin Cities, these institutions are available for industrial experimentation and research. A chapter of the American Society of Milling and Baking Technology meets in Minneapolis at intervals during the winter months, the meetings being well attended by local cereal chemists.

PLANT PATHOLOGY AND AGRICULTURAL BOTANY

Unusually good facilities are offered by the Division of Plant Pathology for the pursuit of graduate studies. Nearly all of one building is devoted to plant pathology and much of this is used for the graduate instruction and research. Four large rooms are fully equipped for laboratory investigations in the various phases of plant pathology and provide ample individual space for a relatively large number of students. A mycological herbarium of approximately 25,000 specimens supplemented by a substantial pathologium is housed in a spacious room which is also equipped for mycological research. There is a departmental library of approximately 500 books in addition to most of the important periodicals relating to mycology and plant pathology, as well as large collections of bulletins and separates. The main agricultural library with 33,000 volumes, the botanical and general library of the Minneapolis campus, as well as the large reference libraries of the Twin Cities are readily accessible.

Two large greenhouses, a section of which contains facilities for soil temperature control, are used for graduate research in plant pathology. An experimental field of five acres is devoted to plant pathological experiments. A substantial field house containing a field laboratory is conveniently situated near this field. For investigations of diseases of crops, which are more or less restricted to various sections of the state, facilities are available at the substations at Duluth, Grand Rapids, Crookston, Morris, and Waseca. For dendropathological work, facilities are available at the Itasca and Cloquet substations.

The University of Minnesota being situated in the heart of the spring wheat area has naturally become the center of investigations of cereal diseases, especially of the black stem rust. The coöperation of the office of cereal investigations of the United States Department of Agriculture has broadened the scope of this work, making it the most important work of its kind in the country. The Division of Plant Pathology is working also in close coöperation with the State Department of Agriculture. The office of potato seed certification of the State Department is in the Plant Pathology Building and its work is correlated closely with the work of the Division of Plant Pathology, enabling students of potato diseases to keep in very close touch with the potato-growing industry.

Interdepartmental coöperation within the University is always encouraged. Most of the important investigations being pursued in the Division of Plant Pathology are in coöperation with one or more departments.

SOILS

The Division of Soils has a modern equipment for the study of the chemical and physical properties of soils, including a constant temperature room and a greenhouse.

For field experiments on the use of fertilizers, manures, and soil amendmments, and in soil management, it not only has facilities at University Farm, and at five substations—Crookston, Morris, Grand Rapids, Duluth, and Waseca—but has under its charge the eleven experimental fields leased by the University for the specific purpose of carrying on such experiments. Of these, three represent high-lime peats—Coon Creek, Golden Valley, and Fens—four are on the lighter type of sands—Coon Creek, Crow Wing, Backus, and Bemidji—and four, on the low-lime silt loams of southeastern Minnesota—Hayfield, Kenyon, Aspelund, and Caledonia.

The soil survey of the state, recently begun, is under the supervision of the division, thus permitting soils students an opportunity during the summer to acquire field training while receiving remuneration.

The soils of the state, while of almost exclusively glacial origin, show a wide range in character. Most of them have been formed upon the mantle of drift left by the ice and the others upon the aeolian and lacustral deposits derived from this. They range from the black calcareous prairie soils of the western and southwestern counties to characteristic podzols in the coniferous forests of the northeast. Soils developed on four glaciations are to be found for investigation within convenient driving distance of the laboratory.

COURSE DESCRIPTIONS

NOTE.—Class schedules in the following course descriptions should be verified by reference to the program of the college in which the course is given.

BACTERIOLOGY

(Department of Bacteriology and Immunology, Medical School)

INTRODUCTORY COURSES

ISu,f,w,s. GENERAL BACTERIOLOGY. Prerequisites: 10 credits in chemistry and 10 credits in biology. Five credits. V, VI, VII; MWF. DR. LARSON, DR. HENRICI, MISS BENTON.

ADVANCED COURSES

For advanced work, and with the consent of the major adviser, courses in botany, plant chemistry, physiologic chemistry, pathology and plant pathology may be accepted as major work.

101f,su. SPECIAL MEDICAL BACTERIOLOGY. The pathogenic bacteria; principles of infection and immunity. Prerequisite: general bacteriology. Four credits. I, II; MWF. DR. LARSON.

103w. SPECIAL BACTERIOLOGY FOR STUDENTS OF AGRICULTURE. Bacteriology of the soil, the nitrogen-fixing bacteria; bacteria that cause plant diseases; bacterial diseases of domestic animals; the bacteriology of milk and dairying. Prerequisite: general bacteriology. Four credits. III, IV; TThS. DR. HENRICI.

105f. HOUSEHOLD BACTERIOLOGY. The decay, fermentation, and putrefaction of foodstuffs; molds; canning; bacterial food-poisoning. Prerequisite: general bacteriology. Three credits. VI, VII; TTh. MISS BENTON.

114s. THE HIGHER BACTERIA. Morphology, cultivation, and classification of actinomycetes, yeasts, and molds. Prerequisites: general and special bacteriology. Three credits. VI, VII; TTh. DR. HENRICI.

116w. COURSE IN IMMUNITY. Laws of hemolysis. Quantitative relationship between antigen and antibody. Wasserman reaction. Opsonins. Vaccines. Precipitin reaction. Blood-grouping. Abderhalden reaction. Anaphylaxis. Prerequisite: Course 101 or 103. Three credits. VI, VII; TTh. DR. LARSON.

117s. PATHOGENIC PROTOZOA. Parasitic Protozoa of man; including spirochaets; their morphology and life histories; cultural methods. Prerequisites: general and special bacteriology; Animal Biology 144-145-146. Three credits. VI, VII; TTh. DR. LARSON.

- 118f. MORPHOLOGY AND TAXONOMY OF BACTERIA. Cytology of bacteria; morphology, biochemical, and immunological characters as data for classification. Prerequisites: general and special bacteriology. Three credits. VI, VII; TTh. DR. HENRICI.
- 119f. BACTERIOLOGICAL CHEMISTRY. Chemical analyses of bacteria; bacterial metabolism; factors stimulating enzyme production; nitrogen fixation. Prerequisites: general and special bacteriology; physiologic chemistry or phytochemistry. Four credits. V, VI, VII; TTh. MR. GREEN.
- 120w. CONTINUATION OF 119f. Bacterial toxins; "Split proteins"; bacterial activity in the alimentary tract; pigment production; autolysis of bacteria; immunochemistry; permeability of bacterial cells; behavior of bacteria toward electricity. Sixty-six hours; 4 credits. V, VI, VII; TTh. MR. GREEN and assistant.
- 150f-151w or 150w-151s. ADVANCED BACTERIOLOGY. Special problems. Prerequisites: general and special bacteriology. Limited to ten students. Arrange credits. DR. LARSON, DR. HENRICI.
201. RESEARCH IN BACTERIOLOGY. Hours and credits arranged. DR. LARSON, DR. HENRICI.
203. SEMINAR IN BACTERIOLOGY. One credit. Staff.

BOTANY

(Department of Botany, College of Science, Literature, and the Arts)

INTRODUCTORY COURSES

- 1f-2w. GENERAL BOTANY. Ten credits. Sec. 1. Lab. I, II; MWF. Quiz. I; T. Lect. II; TThS. Sec. 2. Lab. V, VI; MWF. Quiz. IV; T. Lect. V, VI; T; V; Th. MR. DURAND, MR. BUTTERS, MR. HUFF, MR. JOHNSON, and assistants.
- 4f-5w-6s. GENERAL BOTANY. Same as Course 1-2, extended throughout three quarters. For students in agriculture and forestry only. Nine credits. Lect. VII; TTh. Lab. V, VI; TTh. MR. DURAND.
- 7s. TAXONOMY OF FLOWERING PLANTS. A general study of the classification and relationships of flowering plants. Prerequisite: Course 2 or 4-5. Five credits. Lab. V, VI; MWF. Quiz. V; Th. Lect. VI; TTh. MR. ROSENDAHL, MR. JOHNSON.
- 8s. GENERAL BOTANY. A course adapted to the needs of students in home economics. Five credits. Lect. II; TThS. Lab. I, II; MWF. MR. DURAND.
- 12f. GENERAL MORPHOLOGY OF ALGAE. Prerequisite: Course 2 or 6. Three credits. I, II; TThS. MISS TILDEN.

- 13w. GENERAL MORPHOLOGY OF FUNGI. Prerequisite: Course 2 or 6. Three credits. -I, II; TThS. MR. JOHNSON.
- 17f-18w-19s. GENERAL BOTANY AND GREENHOUSE WORK. Study of external forms of flowering plants and special study of the flower with the outline of classification of flowering plants. For pharmacy students only. Nine credits. V, VI, VII; MW. MR. BUTTERS.
- 20f. FOREST ECOLOGY. Prerequisite: Course 2 or 4-5. Three credits. Ar. Ar. MR. COOPER. *
- 21s. ELEMENTARY ECOLOGY. An introductory course in the study of plants in relation to their environment. Prerequisite: Course 2 or 4-5. Five credits. III, IV; MTWFS. MR. COOPER.
- 22f,s. ELEMENTARY PLANT PHYSIOLOGY. An introductory course giving a general survey of plant functions. Prerequisite: Course 2 or 4-5 and organic chemistry advised. Five credits. III, IV; MTWFS. MR. KNIGHT, MR. HARVEY, MR. FARABAUGH.
- 48f. PLANT INDUSTRY. Lecture demonstration course on relation of plants to modern important industries and conservation policies. Especially for students in Arts and the professions. Given with the coöperation of special lectures from the departments of the plant science group. Five credits. VII; MTWThF. MR. ROSENDAHL, MR. FREEMAN, and special lecturers.
- 51f. HISTOLOGICAL METHODS. Training in the technique of preparing plant material for microscopic study. Prerequisites: 15 credits. Three credits. I, II; MWF. MR. ROSENDAHL.
- 56w-57s. BOTANY OF ECONOMIC PLANTS. A course dealing with the most important botanical features of the common economic plants. Prerequisites: 15 credits. Six credits. III, IV; MWF. MR. HUFF.
- 62w. GENERAL MORPHOLOGY OF BRYOPHYTES AND PTERIDOPHYTES. Structure, evolution, and classification of liverworts, mosses, and ferns. Prerequisites: 15 credits. Three credits. V, VI, VII; TTh. MR. HUFF.
- 63s. GENERAL MORPHOLOGY OF GYMNOSPERMS AND ANGIOSPERMS. Structure, evolution, and classification of seed plants. Prerequisite: Course 7 or 62. Three credits. V, VI, VII; TTh. MR. BUTTERS.
- 107w. MORPHOLOGY AND TAXONOMY OF BRYOPHYTES. Structure and classification of liverworts and mosses. Prerequisites: Courses 7 and 62. Five credits. Ar. Ar. MR. DURAND.
- 108w. MORPHOLOGY AND TAXONOMY OF PTERIDOPHYTES. An intensive study of lycopods, ferns, and their allies; their structure, history, and classification. Prerequisites: Courses 7 and 62. Five credits. Ar. Ar. MR. BUTTERS.

- 110W. MORPHOLOGY AND TAXONOMY OF GYMNOSPERMS. An intensive study of cycads, conifers, and their allies; their structure, history, and classification. Prerequisites: Courses 7 and 63. Five credits. Ar. Ar. MR. BUTTERS.
- 113f-114W-115S. ADVANCED TAXONOMY. Special attention is given to the taxonomy of different natural groups of angiosperms, involving systematic principles and practice, rules of nomenclature, and systems of classification. Prerequisites: 15 credits including Course 7. Nine credits. V, VI; MWF. MR. ROSENDAHL.
- 118W. CYTOLOGY. A study of the origin, development, structure, and functions of the plant cell and its various constituents. Prerequisites: 18 credits. Three credits. V, VI, VII; TTh. MR. ROSENDAHL.
- 123-124-125-126. MORPHOLOGY AND TAXONOMY OF THE ALGAE. Myxophyceae, Chlorophyceae, Phaeophyceae, Rhodophyceae. Advanced studies in selected groups. Any of the courses may be taken separately. Prerequisites: 15 credits including Course 12. Twelve credits. V, VI, VII; TTh. MISS TILDEN.
127. ANATOMY OF VASCULAR PLANTS. A study of the microscopic structure of vascular plants with particular attention to the development and evolution of the vascular system in the root, stem, and leaf. Prerequisites: 18 credits. Five credits. III, IV; MTWFS. MR. BUTTERS.
- 131f. FIELD ECOLOGY. A survey of the local communities and successions followed by a written report, and by a study of the general principles of plant association and succession. Prerequisite: Course 21. Five credits. Ar. Ar. MR. COOPER.
132. ECOLOGICAL ANATOMY. The individual plant and its parts as related to environment; special plant forms and structures, their causes and significance. Prerequisite: Course 21. Five credits. III, IV; MTWFS. MR. COOPER.
- 133S. FOREST GEOGRAPHY OF NORTH AMERICA. Preliminary discussion of the principles of plant distribution followed by a detailed study of the forest regions of North America. Prerequisite: Course 21. Five credits. V, VI; MWF. MR. COOPER.
141. PHYSICAL PHASES OF PLANT PHYSIOLOGY. The intake and translocation of materials, and the energy relations of the plant. Prerequisite: Course 22, and general organic chemistry advised. Five credits. I, II; MTWThF. MR. KNIGHT, MR. HARVEY, MR. FARABAUGH.
142. PLANT METABOLISM. The synthesis of plant food, its transformation and utilization by the plant. Prerequisite: Course 22, and general organic chemistry advised. Five credits. I, II; MTWThF. MR. KNIGHT, MR. HARVEY, MR. FARABAUGH.

143. PLANT METABOLISM AND GROWTH. A continuation of Course 142, dealing with respiration, growth, and movement. Prerequisite: Course 22, and general organic chemistry advised. Five credits. I, II; MTWThF. MR. HARVEY, MR. KNIGHT, MR. FARABAUGH.
144. PLANT MICROCHEMISTRY. A study of the localization of materials of physiological importance in the plant and their relation to physiological processes. Prerequisite: Course 22, and general organic chemistry advised. Five credits. III, IV; MTWFS. MR. HARVEY.

COURSES PRIMARILY FOR GRADUATE STUDENTS

- 201-202-203. RESEARCH PROBLEMS IN THE MORPHOLOGY OF VASCULAR PLANTS. MR. BUTTERS.
- 205-206-207. RESEARCH PROBLEMS IN THE TAXONOMY OF ANGIOSPERMS. MR. ROSENDAHL.
- 209-210-211. RESEARCH PROBLEMS IN ALGAE. MISS TILDEN.
- 213-214-215. RESEARCH PROBLEMS IN EMBRYOLOGY. MR. DURAND.
- 217-218-219. SPECIAL RESEARCH PROBLEMS IN THE TAXONOMY AND DISTRIBUTION OF ALGAE. MISS TILDEN.
- 221-222-223. RESEARCH PROBLEMS IN ECOLOGY. MR. COOPER.
224. RESEARCH METHODS IN PLANT PHYSIOLOGY. MR. HARVEY, MR. KNIGHT.
- 225-226-227. RESEARCH PROBLEMS IN PLANT PHYSIOLOGY. MR. KNIGHT, MR. HARVEY.
- 229-230-231. RESEARCH PROBLEMS IN CYTOLOGY. MR. ROSENDAHL.
- 233-234-235. SEMINAR. Students may register for one hour seminar credit per quarter in any of the above research subjects.

FARM CROPS

(Division of Agronomy and Farm Management, College of Agriculture, Forestry, and Home Economics)

INTRODUCTORY COURSES

- 1f,w,s,su. FARM CROPS. An elementary study of the general problems of crop production together with the important field crops of the United States. Three credits. III, IV; MWF. MR. STEINMETZ.

ADVANCED COURSES

For advanced work and, with the approval of the adviser, courses in agricultural biochemistry, botany, genetics, horticulture, plant-breeding, plant pathology, and plant physiology may be accepted as major work.

- 121f. CEREAL CROPS. An advanced study of the cereal crops. Structure, group classification, improvement, growing, and utilization. Prerequisites: Course 1, botany 9 credits. Three credits. V, VI, VII; TTh. MR. ARNY, MR. MCGINNIS.
- 122w. CORN AND POTATO CROPS. A study of the corn and potato crops similar to that outlined for Course 121. Prerequisites: Course 1, botany 9 credits. Three credits. V, VI, VII; TTh. MR. ARNY, MR. MCGINNIS.
- 123s. FORAGE AND FIBER CROPS. A study of forage and fiber crops. Prerequisites, Course 1, botany 9 credits. Three credits. V, VI, VII; TTh. MR. ARNY, MR. MCGINNIS.
209. RESEARCH IN FARM CROPS. Prerequisites: 9 credits in farm crops. Three to 9 credits. Ar. MR. ARNY.
- 213f,w,s. FARM CROPS SEMINAR. Discussion of problems, reviews of literature, and reports of thesis problems. Prerequisites: 9 credits in farm crops. Maximum of 3 credits. MR. ARNY.
214. SPECIAL TOPICS IN FARM CROPS LITERATURE. Prerequisites: Agronomy and Farm Management Courses 121f, 122w, 123s and a reading knowledge of German. Maximum of 6 credits. Ar. MR. ARNY.

FORESTRY

(College of Agriculture, Forestry, and Home Economics)

INTRODUCTORY COURSES

- 1f,s. GENERAL FORESTRY. The development of forestry in Europe and America; its bearing on the forestry problems of the United States; description of the United States forests. Four credits. II; MTWF. MR. CHEYNEY.
- 2su. ELEMENTARY DENDROLOGY. The trees and shrubs found in Itasca Park, with special reference to identification by means of gross characters. Two credits. Ar. (Offered at Itasca Station.) MR. WENTLING.
- 3f-4w. DENDROLOGY. The forest trees of the United States; their classification, characteristics, and range. Prerequisite: Botany 4. Eight credits. Lect. II; TThS. Lab. VI, VII, VIII; M. MR. WENTLING, MR. DEFLOON.
- 5su. ELEMENTARY SYLVICULTURE. Largely field work. Sylvicultural study of the species found in the north woods and the general principles underlying sylvicultural reconnaissance. Two credits. Ar. (Offered at Itasca Station.) MR. WENTLING.

9. ELEMENTARY MENSURATION. Largely field work. Timber-cruising, valuation surveys, stem analysis, and the study of the measurements of stand, volume, and yield. Two credits. Ar. (Offered at Itasca Station.) MR. ALLISON.
10. FOREST MENSURATION. Measurement of standing and felled timber. Special attention is given to log rules, preparation and use of volume tables, growth of trees, and yield table. Prerequisite: Course 3-4. Five credits. IV; MTWFS. MR. HANSEN.
- 11f. FOREST VALUATION. The business of forest management. Prerequisites: Courses 10, 41. Five credits. I; MTWThF. MR. ALLISON.
- 20w. GRAZING. History of grazing in the west. Kinds of stock used. Forage plants. Regulations and methods of handling stock. Range management and protection. Three credits. III; TThS. MR. ALLISON.
23. FACTORY EXPERIENCE. Two or more months in a factory utilizing wood by-products. Prerequisite: Course 33-34. Three or 5 credits. Ar.
- 26f,w. TREE CROPS. The relation of the forest to agriculture and animal husbandry. The farm and timber supply. One credit. IV; TS. MR. CHEYNEY.
- 27w. GROVES AND WINDBREAKS. Planning and planting farm windbreaks and shelterbelts. Utilization and marketing of farm, grove, or woodlot products. Three credits. I; MWF. MR. WIGGIN.
- 28w. LOGGING. The practice, cost, and development of the different logging methods in use in the different forest regions of the United States, and the modifications required by forest management. Prerequisite: Course 3-4. Three credits. III; MWF. MR. CHEYNEY.
- 29f. SAWMILL AND WOOD-WORKING MACHINERY. Prerequisite: Course 33-34. Three credits. IV; MWF. MR. CHEYNEY.
- 30s. SEASONING OF WOOD. Air seasoning and kiln drying the different species of wood and the different forms of wood products; the results obtained and the defects to be avoided. Prerequisite: Course 33-34. Three credits. III; MWF. MR. CHEYNEY.
- 32w. LUMBER DISTRIBUTION. The standing timber of the United States in its relation to the lumber market. The organization of the industry and the distributing agencies. Prerequisite: Course 33-34. Five credits. II; MTWThF. MR. CHEYNEY.
- 33f-34w. WOOD STRUCTURE AND IDENTIFICATION. The structure, classification, and identification of the most important commercial domestic and foreign woods. Prerequisites: Course 3-4, Botany 4-5-6. Six credits. V, VI, VII; WF. MR. WENTLING.

- 35w. SEEDING AND PLANTING. The cultural principles, operations, methods, and equipment in nursery work and artificial regeneration. Prerequisite: Course 41. Three credits. III; MWF.
- 36w. POLICY AND ADMINISTRATION. Policy of the United States and the states toward the utilization of the public forest resources. Policy of other owners towards forest resources controlled by them. Administration of the national and state forests. Prerequisites: Courses 43 and 11, 28 parallel. Five credits. I; MTWThF. MR. ALLISON.
- 39f. WOOD PRESERVATION. The history, development, and methods of wood preservation. Prerequisite: Course 33-34. Three credits. II; TThS. MR. ALLISON.
- 40s. FOREST BY-PRODUCTS. A general survey of forest products other than wood. Three credits. I; MWF. MR. ALLISON.
- 41f. SYLVICS. The basis of silviculture with special attention to the sylvics of the important tree species. Prerequisites: Course 3-4, Botany 4-5-6. Three credits. II; MWF. MR. WENTLING.
- 43s. SYLVICULTURAL LABORATORY. Nursery practice and field-planting. Field investigations and planting plans. Seed-collecting, extracting, and storing. Daily nursery and field work. Prerequisite: Course 35. Six credits. Ar. (Offered at Itasca Station.) MR. WENTLING.
- 44s. WOOD PULP AND PAPER. The manufacture of wood pulp and wood pulp papers. Prerequisites: Course 33-34, Chemistry 3 or 10. Three credits. II; MWF. MR. ALLISON.
- 45s. FOREST REGULATION. The principles of forest regulation. The purpose and preparation of forest working plans. Prerequisites: Courses 43, 11. Three credits. IV; MWF. MR. ALLISON.
- 46s. FOREST REGULATION LABORATORY. Field work. The collection of the data necessary to working up a forest working plan. Prerequisites: Courses 43, 11. Three credits. Ar. (Offered at Itasca Station.) MR. ALLISON.

ADVANCED COURSES

For advanced work, and with the approval of the major adviser, courses in botany, chemistry, entomology, geology, horticulture, plant pathology, plant physiology, and soils may be accepted as major work.

- 101w. ADVANCED DENDROLOGY. A continuation of Courses 3 and 4 with special studies in classification and distribution. Prerequisites: Course 3-4, Botany 4-5-6. Three credits. Ar. MR. WENTLING.
- 106w. RESEARCH METHODS IN SYLVICULTURE. The fundamental principles upon which silviculture is based. Prerequisite: Course 43. Three credits. II; MWF.

- 107f. USES OF WOOD I. The economic hard and soft woods, both foreign and domestic, from standpoint of regions of production, distribution centers, qualities, amounts, and prices in relation to the wood-using industries. Prerequisite: Course 33-34. Three credits. IV; MWF. MR. WENTLING.
- 108w. USES OF WOOD II. Continuation of Course 107 dealing with industries and the woods used. Prerequisite: Course 107. Three credits. IV; MWF. MR. WENTLING.
- 109s. USES OF WOOD III. The actual use of wood in the industries. Open only on completion of Courses 107 and 108. Three credits. IV; MWF. MR. WENTLING.
- 110w. MECHANICAL AND PHYSICAL PROPERTIES OF WOOD. Strength as related to seasoning, mechanical failures, penetration of preservatives, testing timbers. Prerequisite: Course 33-34. Two credits. V, VI; WF. MR. WENTLING.
- 111f. ADVANCED WOOD STRUCTURE. Wood elements and structures as related to seasoning, mechanical failures, penetration of preservatives, etc. Prerequisite: Course 33-34. Three credits. V, VI; MWF. MR. WENTLING.
- 112w. ADVANCED FOREST MENSURATION. Continuation of Course 10. Prerequisite: Course 10. Three credits. Ar. MR. HANSEN.
- 113w. ADVANCED FOREST BY-PRODUCTS. Prerequisites: Course 33-34, Chemistry 3 or 10 and Chemistry 36. Three credits. Ar. MR. ALLISON.
- 201-202. RESEARCH PROBLEMS IN SCIENCE AND PRACTICE OF SYLVICULTURE. MR. WENTLING.
- 203-204. RESEARCH PROBLEMS IN MANAGEMENT AND WORKING PLANS. MR. ALLISON.
- 205-206. LUMBER MARKETS AND PRICES. MR. CHEYNEY.
- 207f-208w-209s. RESEARCH IN WOOD TECHNOLOGY. MR. WENTLING.

GENETICS AND PLANT-BREEDING

(Divisions of Agronomy and Farm Management, and Horticulture, College of Agriculture, Forestry, and Home Economics; and Department of Animal Biology, College of Science, Literature, and the Arts.)

ADVANCED COURSES

For advanced work, and with the approval of the adviser, courses in agricultural biochemistry, botany, farm crops, horticulture, plant pathology, and plant physiology may be accepted as major work.

131. Agronomy or 109 Horticulture. PRINCIPLES OF GENETICS. Fundamental principles of breeding, heredity, variation, biometry, and evolution. Prerequisites: botany 10 credits, animal biology 10 credits. Three credits. I; TTh. I, II; S. MR. BEAUMONT, MR. GRIFFEE.
- 183w. Animal Biology. GENETICS AND EUGENICS. Facts and theories of heredity and the application of the laws governing natural inheritance for the improvement of the race. Prerequisites: biology 15 credits. Three credits. Ar. MR. NACHTRIEB.
- 132s. Agronomy. FARM CROPS PLANT-BREEDING. Applied genetics. Methods of breeding each of the important agricultural crops. Prerequisites: Agronomy 131 or Horticulture 109. Three credits. I; TTh. I, II; S. MR. HAYES, MR. GRIFFEE.
- 110w. Horticulture. HORTICULTURE CROPS-BREEDING. Applied genetics. The method of breeding each of the important horticultural crops. Prerequisites: Agronomy 131 or Horticulture 109. Three credits. I; TThS. MR. BEAUMONT, MR. BUSHNELL.
- 209f-210w-211s-212su. Horticulture. HORTICULTURAL CROPS-BREEDING RESEARCH. Students usually required to continue work over one summer. Ar. MR. ALDERMAN, MR. HAYES.
- 203f,w,s. Agronomy or 213f,214w,215s. Horticulture. PLANT-BREEDING SEMINAR. History of plant-breeding, application of recent genetic theories to crop improvement and a discussion of research problems. Prerequisites: Agronomy 131 or Horticulture 109. Three credits. Ar. MR. HAYES.
201. Agronomy. RESEARCH IN PLANT-BREEDING. Ar. MR. HAYES.
- 211w. Agronomy. TOPICS IN PLANT-BREEDING LITERATURE. Prerequisite: Agronomy 132 or Horticulture 110. Maximum of 6 credits. Ar. MR. HAYES.
- 217f. Agronomy. ADVANCED GENETICS. Prerequisite: Agronomy 131 or Horticulture 109. Three credits per year. Maximum of 6 credits. Ar. MR. HAYES.

HORTICULTURE

(Division of Horticulture, College of Agriculture, Forestry, and Home Economics)

INTRODUCTORY COURSES

- 6f. FRUIT-GROWING. Fundamental principles. Three credits. Sec. 1, Lect. II; MF. Lab. I, II; T or F. Sec. 2, Lect. IV; TTh. Lab. VI, VII; M. MR. ALDERMAN.
- 21w. SMALL FRUIT CULTURE. Prerequisites: Course 6 or 32, botany 9 credits. Three credits. IV; MWF. MR. BRIERLEY.

- 32s. VEGETABLE-GROWING. Three credits. Sec. 1, Lect. II; MW. Lab. I, II; T or F. Sec. 2, Lect. IV; TS. Lab. VI, VII; M. Mr. TAPLEY, MR. BUSHNELL.
- 33w. VEGETABLE-FORCING. Prerequisites: Course 32, botany 9 credits. Three credits. Lect. I; TTh. Lab. V, VI; F. MR. TAPLEY.
- 50s. FLORICULTURE. Three credits. III; MWF. MR. CADY.
- 56s. PROPAGATION AND NURSERY PRACTICE. Three credits. Lect. III; TS. Lab. V, VI; T. MR. CADY.
- 71s. LANDSCAPE GARDENING. Three credits. II; TThS. MR. CADY.
- 91s. ADVANCED GENERAL HORTICULTURE. For students in agricultural education. Three credits. Prerequisite: botany 9 credits. Ar. MR. ALDERMAN, MR. CADY, MR. TAPLEY.
- 93f. JUDGING HORTICULTURAL CROPS. Prerequisite: Course 6 or 32. Two credits. V, VI, VII; T. MR. ALDERMAN, MR. BRIERLEY, MR. CADY, MR. TAPLEY.

ADVANCED COURSES

- 107f. ORCHARD MANAGEMENT. The various operations in orchard and berry fields. Operating costs and profits. Prerequisite: Horticulture 6. Three credits. Lect. III; TTh. Lab. I, II; Th. MR. BRIERLEY.
- 111f. SYSTEMATIC POMOLOGY. Prerequisite: Horticulture 6. Three credits. IV, V, VI, VII; W. MR. ALDERMAN, MR. BRIERLEY.
- 131f. ADVANCED VEGETABLE PRODUCTION. The business of vegetable-gardening, variety improvement, production of seed, investigation, and research. Prerequisite: Horticulture 32. Three credits. Lect. III; MW. Lab. I, II; S. MR. TAPLEY.
- 132f. SYSTEMATIC OLERICULTURE. The origin, botany, varieties, and types of the different vegetables, their characteristics and adaptation to different cultural and market conditions. Prerequisite: Horticulture 32. Three credits. Lect. II; TTh. Lab. V, VI; F. MR. TAPLEY.
- 133w. COMMERCIAL TRUCK-GROWING. Truck-growing centers of the United States, cultural methods, special machinery and equipment, market methods, shipping points. Adaptation of truck crops to Minnesota, commercial production for canneries; handling; shipping to market. Prerequisite: Horticulture 32. Three credits. Ar. MR. TAPLEY.
- 135w. POTATO PRODUCTION. The origin, botany, regional distribution, economic importance, group classification, standardization or varieties according to soil, climate, and markets. Identification, exhibiting,
- 151f. ADVANCED FLORICULTURE. Culture, botany, and history of florists' plants and methods of greenhouse management. Prerequisites: Horticulture 50, botany 9 credits. Three credits. Ar. MR. CADY.

judging, cultural methods, seed selection and certification, marketing, and utilization. Prerequisites: Course 6 or 32, botany 9 credits. Three credits. Lect. III; MW. Lab. V, VI; Th. MR. KRANTZ.

191W-192S. SPECIAL PROBLEMS. Prerequisite: special permission. Two to 4 credits per quarter. MR. ALDERMAN.

193f-194W-195S. HORTICULTURAL SEMINAR. Reports and discussions of problems and investigational work. Required of graduate students. Prerequisite: special permission. One credit per quarter. Ar. Horticultural staff.

201f-202W-203S-204SU. FRUIT-GROWING RESEARCH. Open to those who have specialized in fruit-growing. Three to 6 credits per quarter. Ar. MR. ALDERMAN, MR. BRIERLEY.

231f-232W-233S-234SU. VEGETABLE-GROWING RESEARCH. Open to those who have specialized in vegetable-growing. Three to 6 credits per quarter. Ar. MR. TAPLEY.

242W. METHODS AND INTERPRETATION OF HORTICULTURAL RESEARCH. Two credits. Ar. MR. ALDERMAN.

PHARMACOGNOSY

(College of Pharmacy)

INTRODUCTORY COURSES

- 1S. MEDICINAL PLANT STUDY AND DRUG PREPARATIONS. One credit. Ar. MR. NEWCOMB and assistants.
- 2W. THE PHARMACOGNOSY OF THE THALLOPHYTES, ARCHEGONIATES, AND GYMNOSPERMS. Prerequisite: Course 1. Two credits. Ar. MR. NEWCOMB and assistants.
- 3S. PHARMACO-HISTOLOGY. Includes the micrometry and the detailed study of the inner structure of parts of the higher plants as illustrated by about forty official and unofficial drugs. Prerequisite: Course 2, *Materia Medica I*. Three credits. Ar. MR. NEWCOMB and assistants.
- 4f. DRUG COLLECTION AND PREPARATION. Scientific methods of drug collection and preparation of about fifty drugs from plants grown in the medicinal plant garden. Prerequisite: Course 3. Three credits. Ar. MR. NEWCOMB and assistants.
- 5W. PHARMACOGNOSY OF THE ANGIOSPERMS. The official crude and powdered seeds, roots, rhizomes, barks, woods, pith, flowers, fruits, leaves, herbs, exudations, animal drugs, etc., and their adulteration. Prerequisite: Course 3. Ten credits. Ar. MR. NEWCOMB and assistants.

- 6s. FIELD WORK. Field searches for native medicinal plants. The study of the distinguishing characteristics of certain orders, families, and genera of medicinal plants. Prerequisite: Course 1. Two credits. Ar. MR. NEWCOMB.
- 7w. PHYSIOLOGICAL DRUG ASSAY. The pharmacopoeial and more important unofficial methods of biologic assay. Prerequisite: Course 5. Three credits. Ar. MR. NEWCOMB.
- 8w,s. ADVANCED PHARMACOGNOSY. The use of the more important microscopical accessories in advanced pharmacognostic work. Prerequisite: Course 5. Three credits. Ar. MR. NEWCOMB.

PLANT CHEMISTRY

(Division of Agricultural Biochemistry, College of Agriculture, Forestry, and Home Economics)

INTRODUCTORY COURSES

- 3f,w,s,su. TYPES OF CARBON COMPOUNDS. An elementary study of the different groups of carbon compounds, with special reference to their relationships to biology. Prerequisites: chemistry 10 credits. Six credits. I; MTWThFS. MR. ANDERSON.
- 7f,w-8w,s. GENERAL AGRICULTURAL BIOCHEMISTRY. A qualitative and quantitative study of the types of organic and inorganic compounds found in plants and animals and of the chemical changes involved in metabolism, growth, and maintenance. Prerequisite: chemistry 10 credits. Ten credits. Fall and winter. Lect. II; TThS. Lab. V, VI, VII; MW. Winter and spring. Lect. III; TThS. Lab. V, VI, VII; MF. MR. ANDERSON, MR. HAUGE.

ADVANCED COURSES

For advanced work, and with the approval of the adviser, courses in bacteriology, physical chemistry, organic chemistry, plant physiology, or plant pathology may be accepted as major work.

- 101f,su-102w,su. AGRICULTURAL QUANTITATIVE ANALYSIS. The estimation of inorganic and organic constituents of biological products, the proximate analysis of foods and feeding stuffs, the use of the polariscope, immersion refractometer, colorimeter and nephelometer, viscosimeter, and other special apparatus. Prerequisite: Course 7-8 or organic and quantitative analysis. Six credits. V, VI, VII, VIII; MWF. MR. MORROW.
- 106f. CHEMICAL TECHNOLOGY OF AGRICULTURAL PRODUCTS. The composition of the principal products and by-products of agriculture and their utilization as raw material in various industries, and the methods of chemical control work in these industries. Prerequisite: Course 101-102. Five credits. Ar. MR. BAILEY.

- 108s. CHEMISTRY OF WHEAT AND WHEAT PRODUCTS. The chemical technology of the production and milling of wheat and the conversion of its products into human food. Prerequisite: Course 7-8 or 3. Three credits. I; MWF. MR. BAILEY.
- 110s. FLOUR LABORATORY METHODS. Analysis of wheat and its products; milling tests of wheat, baking, and special tests of flour. Designed to train students for research and control work in the cereal industry. Prerequisite: Course 7-8. Five credits. V, VI, VII, VIII; MWF. MR. BAILEY.
- 111f,su-112w,su. PHYTOCHEMISTRY. The colloidal state, and the chemistry of proteins, carbohydrates, glucosides, tannins, fats, plant acids, enzymes, and pigments and their physicochemical relations to the vital processes involved in growth and nutrition. Prerequisites: Course 3 or 7-8, biology 9 credits. Six credits. III; MWF. MR. MORROW.
- 113f,su-114w,su. BIOCHEMICAL LABORATORY METHODS. A laboratory course paralleling 111, using recent methods for the investigation of biologically important compounds. Prerequisite: quantitative analysis. Four credits. V, VI, VII, VIII; TTh. MR. MORROW, MR. EVANS.
- 118f,w,s,su. LABORATORY PROBLEMS IN BIOCHEMISTRY. Three to 5 credits. Ar. MR. GORTNER, MR. BAILEY, MR. PALMER, MR. MORROW, MR. WILLAMAN.
- 201f,w,s,su. SEMINAR. Required of all majoring in this division and of all minoring for the doctor of philosophy degree. One credit. Ar. MR. GORTNER.
- 203f,w,s,su. RESEARCH PROBLEMS. Three or 5 credits. Ar. MR. GORTNER, MR. BAILEY, MR. PALMER, MR. MORROW, or MR. WILLAMAN.
- 205f,w,s,su. SPECIAL TOPICS IN BIOCHEMICAL LITERATURE. A reading knowledge of German is necessary and of French desirable. Prerequisite: Course 206, 207, or 208. Three credits. Ar. MR. GORTNER.
- 206f. COLLOIDS. Particular emphasis to colloids in biology. Prerequisite: Course 111-112, or physical chemistry. Three credits. II; MWF. MR. GORTNER.
- 207f. ENZYMES. Prerequisite: Course 111-112 or physiologic chemistry. Three credits. III; MWF. MR. WILLAMAN.
- 208w. PROTEINS. Prerequisite: Course 111-112 or advanced organic chemistry. Three credits. II; MWF. MR. GORTNER.
- 209w. CARBOHYDRATES. Prerequisite: Course 111-112 or advanced organic chemistry. Three credits. III; TThS. MR. MORROW, MR. WILLAMAN.

PLANT PATHOLOGY

(Division of Plant Pathology and Botany, College of Agriculture, Forestry, and Home Economics)

INTRODUCTORY COURSES

- 1f,su. PLANT PATHOLOGY. Prerequisites: botany 9 credits. Five credits. V, VI, VII, VIII; MWF. MR. STAKMAN, MR. LEACH, MR. SEAL.
- 10f. FOREST PATHOLOGY. (Offered in alternate years. Given in 1922-23.) Prerequisites: botany 9 credits. Five credits. V, VI, VII, VIII; MWF. MR. STAKMAN, MR. LEACH, MR. SEAL.
- 14s. PLANT DISEASE CONTROL. (Offered in alternate years. Given in 1922-23.) Prerequisites: Course I, Entomology 1 or 3. Five credits. Ar. MR. BARKER.

ADVANCED COURSES

For advanced work, and with the approval of the adviser, courses in botany, plant physiology, bacteriology, entomology, and plant chemistry may be accepted as major work.

- 105f-106w-107s. MYCOLOGY. The morphology, taxonomy, and biology of fungi. Prerequisite: Botany 7, 11, or equivalent. Nine credits. III, IV; MWF. MISS DOSDALL.
- 108f-109w. METHODS. Plant pathological methods including mycological and bacteriological technique. Prerequisites: Course I, Bacteriology I. Six credits. I, II; MWF. MR. LEACH.
- 110s. PRINCIPLES OF PATHOLOGY. Comparative biology of plant pathogens; pathological plant anatomy; parasitism, biologic specialization, resistance, and immunity. Will be given in close coöperation with the Division of Agricultural Biochemistry and divisions offering work in plant-breeding. Prerequisites: Course I, Bacteriology I. Three credits. I, II; MWF. MR. STAKMAN, MR. BARKER.
- 111w,su. DISEASES OF FIELD CROPS. Symptomatology, etiology, and practical methods of control. Prerequisite: Course I. Three credits. V, VI; MWF. MR. STAKMAN, MR. BARKER.
- 112s. DISEASES OF FRUIT CROPS. Special study of diseases of fruit crops, especially those important in Minnesota. Laboratory, lecture, and greenhouse work. Prerequisite: Course I. Three credits. V, VI; MWF. MR. LEACH.
- 113s. DISEASES OF VEGETABLE CROPS. A detailed study of diseases of potatoes and other vegetable crops. Lecture, reference, laboratory, and greenhouse work. Prerequisite: Course I. Three credits. Ar. MR. LEACH.

- 114W. ADVANCED FOREST PATHOLOGY. A detailed study of wood rots, including a study of the deterioration of wood products caused by fungi. Lecture, laboratory, and greenhouse work. Prerequisite: Course I. Three credits. Ar. MR. STAKMAN, MR. LEACH.
- 203f-204W-205S. SPECIAL PROBLEMS. Ar. MR. FREEMAN, MR. STAKMAN.
- 207f-208W-209S. RESEARCH IN MYCOLOGY. Prerequisites: Plant Pathology and Botany 105-106-107. Three credits per quarter. Ar. MR. FREEMAN, MR. STAKMAN.
211. HISTORY OF PLANT PATHOLOGY. Three credits per quarter. Ar. MR. STAKMAN.
213. SEMINAR. Assigned topics with special reference to current pathological problems. Two credits per quarter. Ar. MR. FREEMAN, MR. STAKMAN.

SEED-TESTING

(Division of Plant Pathology and Botany, College of Agriculture, Forestry, and Home Economics)

INTRODUCTORY COURSES

- 7W. WEEDS AND GRASSES. Agricultural and applied botanical study with special reference to agricultural importance. Prerequisites: botany 9 credits. Three credits. V, VI, VII; WF. MR. LARSON.
- 9f, su. WEEDS AND SEED-TESTING. Seed-testing methods and seed legislation. Prerequisites: botany 9 credits. Three credits. V, VI, VII; WF. MR. LARSON.
- 12W. SEED PROBLEMS. Prerequisite: Course 9. Three credits. Ar. MR. LARSON.

SOILS

(College of Agriculture, Forestry, and Home Economics)

INTRODUCTORY COURSES

- 4f. SOILS. Origin, formation, composition, classification, physical properties, moisture relations; principles of tillage. Prerequisites: chemistry 10 credits. Three credits. Lect. III; TTh. Lab. III, IV; S. MR. ROST.
- 5S. SOIL FERTILITY. Soil organisms; use of lime, commercial fertilizers, stable manure, and green manures in relation to crop production. Prerequisite: Course 4. Three credits. Lect. III; TTh. Lab. III, IV; S. MR. ALWAY, MR. ROST.

ADVANCED COURSES

- 101f. CHEMICAL ANALYSIS OF SOILS. Prerequisites: Course 5 and quantitative analysis. Three to 5 credits. Ar. MR. ROST.

- 102W,S. SPECIAL PROBLEMS IN SOILS. Ar. Mr. ALWAY.
- 104S. SOIL-SURVEYING. Field practice in surveying soils and the preparation of soil maps. Prerequisite: Course 108. Three credits. Ar. Mr. McMILLER.
- 105W. MINNESOTA SOILS. Origin, formation, and classification; physical fertilizers, and soil amendments; naturally unproductive types and chemical characteristics; moisture relations; response to manure, their reclamation. Prerequisite: Course 5. Three credits. Ar. Mr. ALWAY.
- 106W. PEAT SOILS. Formation, chemical composition, physical properties, classification, and reclamation. Prerequisite: Course 5. Two credits. Ar. Mr. ALWAY.
- 107W. FERTILIZERS AND MANURES. Sources, composition, and uses. Prerequisite: Course 5. Two credits. Ar. Mr. ROST.
- 108W. PHYSICAL PROPERTIES OF SOILS. A laboratory course. Prerequisite: Course 5. Three credits. Ar. Mr. McMILLER.
- 201W. CLASSIFICATION OF SOILS. Individual work. Open only to those graduates who have a reading acquaintance with French and German. Prerequisites: Soils 1, 3, 104, and 105. Three credits. Ar. Mr. ALWAY.
- 202f,W,S. RESEARCH IN SOILS. Credit according to work. Ar. Mr. ALWAY.
- 203W. SEMINAR IN SOILS. Review of literature and research; study of methods of investigation of soils. Required of graduate students. No credit. VII; T. Mr. ALWAY.



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